Human Health Risk Assessment Summary for the Consumers Energy Karn/Weadock Generating Complex Proposed Modifications (PTI Application # 341-07)

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Robert Sills, Supervisor, Toxics Unit, MDEQ-Air Quality Division (AQD)

This paper provides a brief summary of the human health risk assessment elements that have been included for the subject permit application for a new advanced supercritical pulverized coal (ASCPC) electrical generating unit (boiler).

Air Toxics Assessment

All air contaminants other than 41 exempt substances (which includes the six EPA criteria pollutants) are regulated by MDEQ-AQD as toxic air contaminants (TACs). Under the Air Pollution Control Rules, Part 55 of the Natural Resources and Environmental Protection Act, the proposed emissions of the project were evaluated by comparison of the project's modeled maximum ambient air impacts to the applicable health risk-based screening levels for TACs. This is the standard and required level of air toxics risk assessment under the New Source Review program, and typically, that is the extent of the risk assessment scope. For the subject application review, additional risk assessment steps were also performed, utilizing appropriate environmental modeling tools and risk assessment guidance, as further described in sections below.

The comparison of the project's TAC emissions and modeled ambient air impacts to the health risk-based screening levels determined that all of the modeled impacts were below the applicable screening levels. For noncarcinogens, the highest percentage of a screening level posed by a TAC impact was 3.5% (for manganese). For carcinogens, the highest percentage of a screening level (1-in-one million cancer risk) was 44% (for arsenic). Under the Air Pollution Control Rules, maximum ambient air impacts which are no higher than the applicable health risk-based screening levels are acceptable.

Lead Emissions Impact Assessment

The applicant performed an assessment of the project's lead air emissions and deposition impacts, and the multipathway impacts to children's lead exposure and blood lead levels. The results are presented in SAFRISK (2008). The assessment was based on a lead emission rate of 573 lbs/yr, which is reasonably consistent with the proposed permitted emission rate (580 lbs/yr). That assessment was supplemented by additional analyses of the potential lead impacts (Sills, 2008). Both of the assessments focused on the potential impacts to children, who are a particularly susceptible subpopulation. The assessments were done in a "cumulative" approach, where the potential background levels were accounted for. Multiple pathways of children's lead exposure (food, water, air, soil, and house dust) were included. It is staff's conclusion that the modeled impacts of the project's lead emissions are very small and do not pose a public health threat. As one indicator of the magnitude of the impact, the proposed project was modeled to result in an ambient air impact in residential areas of approximately 0.000019 (1.9E-05) micrograms per cubic meter (ug/m^3). This can be compared to the National Ambient Air Quality

Standard (NAAQS) of 0.15 ug/m^3, and an estimated background level of 0.01 ug/m^3 for this area of the State. The modeled incremental impact is approximately 7,900 times lower than the NAAQS. Consideration of the potential incremental impact of the project's lead emissions to children's multipathway lead exposure resulted in Staff's conclusion that the potential impact is very small and not injurious to the public health. Further details are available in the above referenced documents.

Mercury Emissions Impact Assessment
Generally speaking, mercury air emissions can potentially pose a concern for atmospheric deposition and bioaccumulation, particularly in fish. Therefore, the potential impacts of the proposed project's mercury emissions were characterized via risk assessment. At the request of MDEQ, the applicant provided a human health risk assessment of the proposed project mercury emissions and impacts to fish mercury levels and to the sport anglers who may eat their catch.

The draft permit limit for mercury emissions is 0.0079 lbs/GW-hr (gigawatt-hour, gross energy output), which is equivalent to approximately 63 lbs/yr (Riddle, personal communication). The potential impacts of the proposed project's mercury emissions to the local environment were evaluated by the applicant based on an estimated emission rate of 64 lbs/yr (SAFRISK, 2008). Mercury emissions and impacts were evaluated to determine if there are concerns for ambient air impacts, as well as impacts due to deposition, persistence, and bioaccumulation in fish. The findings of the assessment are summarized as follows.

The mercury emissions of the project were modeled to result in an ambient air impact concentration of 0.0000008 (8E-07) micrograms per cubic meter (ug/m^3) of total mercury, annual averaged, in the relatively more impacted residential areas near the facility. This may be compared to the EPA Reference Concentration (RfC) of 0.3 ug/m^3, which is the level that is protective of everyone from any adverse health effects due to direct inhalation over a lifetime of exposure. Thus, the impact is 375,000 times lower than the Reference Concentration, although it should be noted that the Reference Concentration does not address deposition impacts and indirect exposure pathways such as fish consumption. The ambient air level of mercury in the Great Lakes basin has been estimated as 0.001 to 0.0035 ug/m^3 (MDEQ, 2008).

Mercury air emissions can be expected to disperse and undergo long-range transport, with some amounts of deposition to the ground and surface waters as the plume travels. Locations closer to the emission source generally receive more deposition impact than sites further away. The facility is located near some particular surface water bodies which support recreational fishing, and which may be reasonably presumed to be relatively more impacted than more distant water bodies or very voluminous water bodies (e.g., Saginaw Bay and Lake Huron). Therefore, the impacts to the Tobico Marsh, the Kawkawlin River, and the Saginaw River were evaluated (SAFRISK, 2008). Based on the findings, the Kawkawlin River was the relatively more impacted of those three water bodies. Therefore, SAFRISK (2008) presented in greater detail the mercury impact modeling results for the Kawkawlin River.

For the deposition modeling study, it was assumed that the facility would operate for 30 years, with the mercury emissions from the project assumed to occur continuously at the evaluated emission rate (SAFRISK, 2008). The fraction of mercury in air emissions which may deposit to the ground or surface waters is expected to undergo environmental fate processes, such as runoff and bioaccumulation. The modeling study utilized state-of-the-art EPA models for those deposition and environmental fate processes. The modeling provided estimates of the facility's impacts to mercury levels in surface waters and fish, and the potential exposure to sport anglers (adults and children) who eat their catch. The modeling also estimated mercury exposure for children that may live near the facility and who may be exposed by breathing the air, contacting the soil, and eating food from their gardens, as well as from eating fish from the Kawkawlin River.

The results of the modeling were compared to certain criteria levels for environmental protection. The criteria for environmental protection include 1.3 nanograms per liter (ng/l) for surface water, and 0.35 parts per million (ppm; also called milligrams per kilogram, mg/kg) for fish tissue. The surface water mercury level of 1.3 ng/l is the MDEQ water quality standard. That is the level that is protective for avian wildlife. The MDEQ surface water criterion that is protective for people who catch and eat sportfish is actually somewhat less restrictive: 1.8 ng/l. The mercury fish tissue level of 0.35 ppm is the value utilized by MDEQ to help determine if surface waters are supporting all designated uses, particularly sportfish consumption. That value was derived based on the level of exposure associated with recreational angling and eating the catch (15 grams per day; about one ½ lb meal every 2 weeks) and the health protective exposure level. That level of 0.35 ppm is more restrictive than the 0.5 ppm criterion which is utilized by the Michigan Department of Community Health as a trigger to advise restricted consumption of sportfish. The results of the modeling of project impacts, and a comparison to the existing levels and criteria levels, are summarized in **Table 1** below. The modeling also estimated that the additional exposure to mercury due to the ASCPC boiler emissions, for the most exposed people living near the source and eating fish from the Kawkawlin River, would be 0.34% of the EPA health protective exposure level.

It is also relevant to compare the project's incremental fish mercury impacts to levels that have been measured in fish. There is a lack of recent data for the Kawkawlin River, although limited information (1988 data) indicate that mercury levels in northern pike (0.2 ppm average, 20-31 inches) were relatively low in comparison to the 0.35 ppm MDEQ comparison value. There are also relatively low mercury levels in Tobico Marsh largemouth bass (0.32 ppm average in 2007 legal size fish) and northern pike (0.23 ppm average in 2007 legal size fish). Similarly, the most recent Saginaw River fish mercury levels indicate relatively low levels in walleye (0.17 ppm average, 2004) and in northern pike (0.13 ppm average, 1993; 21-32 inches). The MDEQ Water Bureau has listed the Saginaw River and Saginaw Bay as being in nonattainment with designated uses based on elevated water mercury levels (Saginaw River) or elevated fish mercury levels in walleye (Saginaw Bay). The Kawkawlin River and Tobico Marsh are not designated as nonattainment for mercury levels (Bohr, 2007).

Table 1. Modeled Incremental Impact of Mercury Emissions From the ASCPC Boiler to the Kawkawlin River, and Relevant and Applicable Comparison Values

Exposure to Recreational Anglers as Percent of EPA Acceptable Exposure	Water mercury level (ng/l)			Fish mercury level (ppm)		
	Incremental impact	Existing level	Criteria level	Incremental impact	Existing level	MDEQ comparison value
0.34% (note #1)	0.015	No data	1.3	0.0016	0.2(note #2)	0.35

1. The comparison of exposure to the EPA acceptable exposure level is normally presented as a Hazard Quotient (HQ). The relatively higher HQ for recreational fishers and recreational fisher children was for the adult fisher and the Kawkawlin River fishery, at 0.0034 (which is equivalent to 0.34% of the EPA acceptable exposure level). This value was derived with an assumed Total Suspended Solids (TSS) level of 10 mg/l; a lower assumed value of 2 mg/l resulted in a lower HQ. This value was derived using the preferred MDEQ method, rather than the USEPA HHRAP default method for modeling bioaccumulation.
2. The Kawkawlin River fish mercury data are limited. The available data (northern pike) are older (1988) and limited to nine fish, of which 8 were sub-legal size (20-22 inches; the legal limit is 24 inches). The overall average was 0.2 ppm. The single legal-size pike (31 inches) had 0.22 ppm mercury (Bohr, 2007).

The model results indicate that the incremental impacts of the proposed project are relatively small in comparison to the applicable comparison values of Table 1. The MDEQ authority and practice under the AQD new source review program is to make case-by-case risk management decisions regarding mercury air emission sources and impacts, to help ensure protection of public health and the environment. Staff believes that the mercury impacts of the proposed project are small and has initially determined that they meet the requirements of the applicable regulations for health protection, pending public comment and a determination by the permit decision-maker.

Cumulative Air Toxics Risk Assessment

In addition to the air toxics assessment and other assessments summarized above, AQD staff evaluated potential concerns for human health risk from the simultaneous exposure to the complex mixture of air toxics in the proposed emissions. That assessment is described below.

The cumulative risk assessment "additivity assessment" approach utilized was based on the screening-level approach described in Sills et al. (2008). The focus of the assessment was the modeled maximum ambient air impact for each substance. As previously noted, the maximum ambient air impact of each individual air toxic substance was compared to the applicable health risk-based screening level. In the "additivity assessment", all those substances which had an impact that was at least 1% of the screening level were initially assumed to act additively for the purposes of evaluating potential noncancer and cancer effects. Further details of the additivity assessment are provided below, for noncarcinogenic and carcinogenic effects.

A. Cumulative noncarcinogenicity risk assessment

The assessment of the potential noncarcinogenic effects of the air toxics, either individually or collectively in the cumulative risk assessment, utilized the AQD's Initial Threshold Screening Levels (ITSLs). An ITSL is the concentration of a substance over a specified averaging time which is protective against noncarcinogenic effects over a lifetime of exposure, as derived according to the Air Pollution Control Rules. The Hazard Quotient (HQ) for a substance is calculated by the environmental level of interest (i.e., the ambient air impact) divided by the health-protective benchmark level (i.e., the ITSL). The sum of all HQs can provide a "Total Hazard Index (HI)". The calculation of a Total HI is a conservative screening approach, without the appropriate separation of substances and HQs according to the target organ or critical effect. A useful and appropriate screening step is to exclude from the additivity calculation all substances with HQ values of < 0.01, i.e., those substances which would have maximum ambient air impact that are less than 1% of their respective ITSLs. The AQD modeling results for the project emission sources (Hengesbach, 2008) were compared to the ITSLs. In this particular case, that step resulted in a finding that only one substance (manganese) had a maximum ambient air impact that was at least 1% of the ITSL (3.5%). Therefore, the Total HI value for the project emissions is 0.035, based on a single substance (manganese).

For mercury, the applicant (SAFRISK, 2008) provided a modeled ambient air concentration for residential areas of 0.0000021 ug/m^3 (total mercury, annual averaging time (AT)). Approximately half of that impact was attributable to elemental mercury, with the balance being divalent mercury vapor and divalent mercury in particulate phase, based on an assumed emission speciation profile. A Hazard Quotient can be derived by the total mercury impact divided by the EPA Reference Concentration (RfC) for elemental mercury (0.3 ug/m^3). The resulting HQ (0.000007) is for inhalation-only exposure; multipathway exposure and risk is addressed in SAFRISK (2008). The HQ presented here is well below the 0.01 criterion for inclusion, but is presented here for clarity and completeness.

For lead, the applicant's modeled maximum ambient air impact was 0.000436 ug/m^3 (24 hr averaging time; Consumers Energy Company, 2007). AQD modeling (Hengesbach, 2008) determined a maximum ambient air impact of 0.000471 ug/m^3 (24 hr averaging time). The modeled ambient air impact for residential areas was 0.000019 ug/m^3 (annual averaging time; SAFRISK, 2008). Lead is an EPA criteria pollutant, not classified as a toxic air contaminant, therefore there is no ITSL. The National Ambient Air Quality Standard (NAAQS) for lead is 0.15 ug/m^3 (3-month averaging time). For the purposes of this additivity assessment, the modeled maximum ambient air impact (24 hr averaging time) was conservatively compared to the EPA NAAQS (0.15 ug/m^3), without attempting to adjust for the differences in averaging times. The resulting HQ (0.003) is well below the 0.01 criterion for inclusion, but is presented here for clarity and completeness. The EPA derivation of the lead NAAQS accounted for deposition and indirect pathways of exposure. Multipathway lead impacts are also addressed in SAFRISK (2008) and Sills (2008), as noted earlier in this paper.

Consideration of "background" levels of air toxics can help to lend perspective to the source impacts. However, this is limited by the lack of air toxics ambient air monitoring data for the area of the facility. The EPA 1999 National Scale Air Toxics Assessment (NATA) provides estimates of hazardous air pollutant concentrations, based on emissions estimates and dispersion modeling. The NATA estimates were developed for risk management considerations and not for direct regulatory applications, and are now somewhat dated (1999). They may still serve as a useful general guide to the background air toxics concentrations and risk levels for cumulative risk assessment. Information was obtained from the EPA's NATA website (http://www.epa.gov/ttn/atw/nata1999/) and from Palma and Strum (2005). For noncancer effects, the focus of the available summary information is on the cumulative Hazard Indices (HIs) for respiratory and neurological effects. HI values that are below 1 indicate that no adverse effects would be anticipated. HI values that exceed 1 do not necessarily indicate that adverse effects would occur, but warrant relatively greater attention and priority for investigation. The counties of Michigan have median (across census tracts) respiratory HIs ranging from less than 1 to the 5-30 range. The respiratory HI sub-ranges listed (and relative frequency of Michigan counties in that range) are: 0-1 (many); 1-2 (many); 2-3 (several); 3-4 (several); 2-5 (few); and, 5-30 (few). Bay County (the location of facility) has a respiratory HI in the 3-4 range. The Risk Maps available at the NATA website indicate that the respiratory HI for the facility area (census tract #285200) is approximately 2.3, predominantly due to on-road sources, and specifically, acrolein concentrations. It may be noted that the acrolein HQ was based on the EPA Reference Concentration (RfC), which was based on a rodent study and incorporated an uncertainty factor of 1000. This helps to indicate the lack of precision, and considerable uncertainty, in the RfC, HQ, and HI values. The NATA-based neurological HI for the facility area is approximately 0.00-0.10.

Mercury and lead are central nervous system (CNS) toxicants. Although the HQ values noted above for these substances do not indicate a concern, individually or cumulatively, these HQs address only inhalation exposure. As indicated previously, the multipathway impacts, exposures and risks of mercury and lead are discussed in detail elsewhere. Although it is possible that lead and mercury exposures, in general, could have cumulative multipathway effects on the CNS, the detailed assessments indicate that the project incremental impacts are quite small. Those assessments also indicate that the "background" exposure sources (for mercury, due to fish consumption; for lead, due to oral exposure to deteriorated house paint containing lead) could potentially be more substantial. These potential exposure situations do not indicate that the project emissions and impacts would be reasonably anticipated to pose a significant cumulative risk for CNS effects alone, in combination, or in the aggregate including potential background sources.

This information does not raise particular concerns for the potential cumulative noncarcinogenic impacts of the complex mixture, for the project alone or in consideration of potential "background" air toxics concentrations based on the limited information described above.

Although the project's air toxics emissions and impacts do not raise concerns for cumulative noncancer respiratory risk, it may be noted that some of the criteria pollutants emitted by the project (SO_2, NO_x, and PM-10) are respiratory tract irritants. The EPA does not evaluate cumulative exposures and risks for the criteria pollutants. But nevertheless, their total ambient air concentrations may be considered here. AQD modeling (Hengesbach, 2009) determined that the SO_2 and NO_x emissions resulted in ambient air impacts that did not exceed significant impact levels for the prevention of significant deterioration. Therefore, further modeling and evaluation was not necessary. For particulate matter (PM10), AQD modeling determined that the project would have insignificant levels of impact at receptor points, or, would have impacts above the level of significance at receptor points yet would not contribute to NAAQS exceedance at those receptor points (Hengesbach, 2009).

B. Cumulative carcinogenicity risk assessment

As with the assessment of noncarcinogenic effects, this additivity assessment utilized a screening criterion of 1% of the screening level to help focus the assessment on the substances that may make a substantive impact on the total risk. The screening level utilized for the screening was the Initial Risk Screening Level (IRSL), which is the ambient air concentration that is associated with an upper-bound cancer risk estimate of 1-in-one million (i.e., 10^{-6}) to an individual with a lifetime of exposure. Therefore, **Table 2** includes only the emitted carcinogenic substances with a modeled maximum ambient air impact that is associated with a risk level of at least 1% of the IRSL (i.e., a risk of at least 1-in-100 million). The modeled ambient air impacts compared to the applicable screening levels were provided by AQD (Hengesbach, 2008). The results are presented in **Table 2**.

Table 2. Additive cancer risk estimate of the project emissions.

Substance	Cancer risk estimates (plausible upper-bound, risk per million people exposed)
Arsenic	0.44
Benzene	0.025
Beryllium	0.012
Cadmium	0.031
Chromium VI	0.20
Formaldehyde	0.017
Nickel	0.018
2,3,7,8-TCDD TEQ	0.046
Total carcinogenic PAHs	0.023
TOTAL	**Total cancer risk = 0.82 ~ 0.8 in 1 million**

The background total cancer risk estimates provided by EPA's NATA 1999 study can help lend perspective to the project's impacts. These indicate that the air toxics levels in counties in Michigan pose an estimated median (across census tracts) cancer risk ranging from the 1-25 in one million range to the 50-75 in one million range. The Michigan county median cancer risk level sub-ranges listed (and relative frequency of Michigan counties in that range) are: 1-25 in one million (many); 25-50 in one million (many); and, 50-75 in one million (several). The risk range category for Bay County and other nearby counties is the 25-50 in one million range (NATA website, and Palma and Strum, 2005).

The census tract of the facility (#285200) had an estimated total air toxics cancer risk level of 26 in one million, primarily attributable to background (16 in one million), area sources (4 in one million), on-road sources (3 in one million), and major sources (2 in one million).

There are no AQD rules or criteria for the acceptability of total (cumulative) cancer risk, for ambient air background levels or for source impacts. The total cancer risk estimate for the project emissions (0.8 in one million) is quite low. This total risk estimate is lower than the acceptable single-substance cancer risk for a project under the New Source Review rules (1 in one million).

References:

Consumers Energy Company. 2007. Toxic Air Contaminant Modeling Analysis – Emission Rates and Results. Air Permit Application, ASCPC Project, October 2007.

Hengesbach, S. 2008. Consumers Energy TAC Modeling Results. Personal communication from Stephanie Hengesbach, MDEQ-AQD to Robert Sills, MDEQ-AQD.

Hengesbach, S. 2009. Personal communication from Stephanie Hengesbach, MDEQ-AQD to Robert Sills, MDEQ-AQD.

MDEQ. 2008. Mercury Strategy Staff Report. Updated August 1, 2008. (See p. 35, and Appendix F.)

Palma, T. and M. Strum. 2005. 1999 National Scale Air Toxics Assessment (NATA) National Scale Assessment. For the Air Toxics Implementation Workshop, March 30, 2005. EPA, Office of Air Quality Planning and Standards.

Riddle, D. 2009. Personal communication from Dave Riddle, MDEQ-AQD to Robert Sills, MDEQ-AQD.

SAFRISK, LC. 2008. Human Health Risk Assessment In Support of Proposed Advanced Supercritical Pulverized Coal (ASCPC) Fired Boiler, Hampton Township, Michigan. October 2007 (Revised April 10, 2008). Appendix H in: Consumers Energy Company. 2007. Permit to Install Application; New Supercritical Pulverized Coal Electrical Generating Unit, Hampton Township, Bay County, Michigan. PTI Application # 341-07.

Sills, R. 2008. Supplemental Lead IEUBK Modeling Results for Recent Coal Fired Power Plant Permit to Install Applications. MDEQ-AQD. August 8, 2008.

Sills, R., M.L. Hultin and M. Depa. 2008. General Approach for the Screening-Level Risk Assessment of Air Toxics Mixtures and Cumulative Risk Assessment. MDEQ-AQD. May 29, 2008.